

UNIT TERMINAL OBJECTIVE

5-10 At the completion of this unit, the paramedic student will be able to integrate pathophysiological principles and assessment findings to formulate a field impression and implement the treatment plan for the patient with an environmentally induced or exacerbated medical or traumatic condition.

COGNITIVE OBJECTIVES

At the completion of this unit, the paramedic student will be able to:

- 5-10.1 Define "environmental emergency." (C-1)
- 5-10.2 Describe the incidence, morbidity and mortality associated with environmental emergencies. (C-1)
- 5-10.3 Identify risk factors most predisposing to environmental emergencies. (C-1)
- 5-10.4 Identify environmental factors that may cause illness or exacerbate a preexisting illness. (C-1)
- 5-10.5 Identify environmental factors that may complicate treatment or transport decisions. (C-1)
- 5-10.6 List the principal types of environmental illnesses. (C-1)
- 5-10.7 Define "homeostasis" and relate the concept to environmental influences. (C-1)
- 5-10.8 Identify normal, critically high and critically low body temperatures. (C-1)
- 5-10.9 Describe several methods of temperature monitoring. (C-1)
- 5-10.10 Identify the components of the body's thermoregulatory mechanism. (C-1)
- 5-10.11 Describe the general process of thermal regulation, including substances used and wastes generated. (C-1)
- 5-10.12 Describe the body's compensatory process for over heating. (C-1)
- 5-10.13 Describe the body's compensatory process for excess heat loss. (C-1)
- 5-10.14 List the common forms of heat and cold disorders. (C-1)
- 5-10.15 List the common predisposing factors associated with heat and cold disorders. (C-1)
- 5-10.16 List the common preventative measures associated with heat and cold disorders. (C-1)
- 5-10.17 Integrate the pathophysiological principles and complicating factors common to environmental emergencies and discuss differentiating features between emergent and urgent presentations. (C-3)
- 5-10.18 Define heat illness. (C-1)
- 5-10.19 Describe the pathophysiology of heat illness. (C-1)
- 5-10.20 Identify signs and symptoms of heat illness. (C-1)
- 5-10.21 List the predisposing factors for heat illness. (C-1)
- 5-10.22 List measures to prevent heat illness. (C-1)
- 5-10.23 Discuss the symptomatic variations presented in progressive heat disorders. (C-1)
- 5-10.24 Relate symptomatic findings to the commonly used terms: heat cramps, heat exhaustion, and heatstroke. (C-3)
- 5-10.25 Correlate the abnormal findings in assessment with their clinical significance in the patient with heat illness. (C-3)
- 5-10.26 Describe the contribution of dehydration to the development of heat disorders. (C-1)
- 5-10.27 Describe the differences between classical and exertional heatstroke. (C-1)
- 5-10.28 Define fever and discuss its pathophysiologic mechanism. (C-1)
- 5-10.29 Identify the fundamental thermoregulatory difference between fever and heatstroke. (C-1)
- 5-10.30 Discuss how one may differentiate between fever and heatstroke. (C-1)
- 5-10.31 Discuss the role of fluid therapy in the treatment of heat disorders. (C-1)
- 5-10.32 Differentiate among the various treatments and interventions in the management of heat disorders. (C-3)
- 5-10.33 Integrate the pathophysiological principles and the assessment findings to formulate a field impression and implement a treatment plan for the patient who has dehydration, heat exhaustion, or heatstroke. (C-3)
- 5-10.34 Define hypothermia. (C-1)

- 5-10.35 Describe the pathophysiology of hypothermia. (C-1)
- 5-10.36 List predisposing factors for hypothermia. (C-1)
- 5-10.37 List measures to prevent hypothermia. (C-1)
- 5-10.38 Identify differences between mild and severe hypothermia. (C-1)
- 5-10.39 Describe differences between chronic and acute hypothermia. (C-1)
- 5-10.40 List signs and symptoms of hypothermia. (C-1)
- 5-10.41 Correlate abnormal findings in assessment with their clinical significance in the patient with hypothermia. (C-3)
- 5-10.42 Discuss the impact of severe hypothermia on standard BCLS and ACLS algorithms and transport considerations. (C-1)
- 5-10.43 Integrate pathophysiological principles and the assessment findings to formulate a field impression and implement a treatment plan for the patient who has either mild or severe hypothermia. (C-3)
- 5-10.44 Define frostbite. (C-1)
- 5-10.45 Define superficial frostbite (frostnip). (C-1)
- 5-10.46 Differentiate between superficial frostbite and deep frostbite. (C-3)
- 5-10.47 List predisposing factors for frostbite. (C-1)
- 5-10.48 List measures to prevent frostbite. (C-1)
- 5-10.49 Correlate abnormal findings in assessment with their clinical significance in the patient with frostbite. (C-3)
- 5-10.50 Differentiate among the various treatments and interventions in the management of frostbite. (C-3)
- 5-10.51 Integrate pathophysiological principles and the assessment findings to formulate a field impression and implement a treatment plan for the patient with superficial or deep frostbite. (C-3)
- 5-10.52 Define near-drowning. (C-1)
- 5-10.53 Describe the pathophysiology of near-drowning. (C-1)
- 5-10.54 List signs and symptoms of near-drowning. (C-1)
- 5-10.55 Describe the lack of significance of fresh versus saltwater immersion, as it relates to near-drowning. (C-3)
- 5-10.56 Discuss the incidence of "wet" versus "dry" drownings and the differences in their management. (C-3)
- 5-10.57 Discuss the complications and protective role of hypothermia in the context of near-drowning. (C-1)
- 5-10.58 Correlate the abnormal findings in assessment with the clinical significance in the patient with near-drowning. (C-3)
- 5-10.59 Differentiate among the various treatments and interventions in the management of near-drowning. (C-3)
- 5-10.60 Integrate pathophysiological principles and assessment findings to formulate a field impression and implement a treatment plan for the near-drowning patient. (C-3)
- 5-10.61 Define self contained underwater breathing apparatus (SCUBA). (C-1)
- 5-10.62 Describe the laws of gasses and relate them to diving emergencies. (C-1)
- 5-10.63 Describe the pathophysiology of diving emergencies. (C-1)
- 5-10.64 Define decompression illness (DCI). (C-1)
- 5-10.65 Identify the various forms of DCI. (C-1)
- 5-10.66 Identify the various conditions that may result from pulmonary over-pressure accidents. (C-1)
- 5-10.67 Differentiate between the various diving emergencies. (C-3)
- 5-10.68 List signs and symptoms of diving emergencies. (C-1)
- 5-10.69 Correlate abnormal findings in assessment with their clinical significance in the patient with a diving related illness. (C-3)
- 5-10.70 Describe the function of the Divers Alert Network (DAN) and how its members may aid in the management of diving related illnesses. (C-1)
- 5-10.71 Differentiate among the various treatments and interventions for the management of diving accidents. (C-3)
- 5-10.72 Describe the specific function and benefit of hyperbaric oxygen therapy for the management of diving

- accidents. (C-1)
- 5-10.73 Integrate pathophysiological principles and assessment findings to formulate a field impression and implement a management plan for the patient who has had a diving accident. (C-3)
- 5-10.74 Define altitude illness. (C-1)
- 5-10.75 Describe the application of gas laws to altitude illness. (C-2)
- 5-10.76 Describe the etiology and epidemiology of altitude illness. (C-1)
- 5-10.77 List predisposing factors for altitude illness. (C-1)
- 5-10.78 List measures to prevent altitude illness. (C-1)
- 5-10.79 Define acute mountain sickness (AMS). (C-1)
- 5-10.80 Define high altitude pulmonary edema (HAPE). (C-1)
- 5-10.81 Define high altitude cerebral edema (HACE). (C-1)
- 5-10.82 Discuss the symptomatic variations presented in progressive altitude illnesses. (C-1)
- 5-10.83 List signs and symptoms of altitude illnesses. (C-1)
- 5-10.84 Correlate abnormal findings in assessment with their clinical significance in the patient with altitude illness. (C-3)
- [5-10.85 Discuss the pharmacology appropriate for the treatment of altitude illnesses. \(C-1\)](#)
- 5-10.86 Differentiate among the various treatments and interventions for the management of altitude illness. (C-3)
- 5-10.87 Integrate pathophysiological principles and assessment findings to formulate a field impression and implement a treatment plan for the patient who has altitude illness. (C-1)
- 5-10.88 Integrate the pathophysiological principles of the patient affected by an environmental emergency. (C-3)
- 5-10.89 Differentiate between environmental emergencies based on assessment findings. (C-3)
- 5-10.90 Correlate abnormal findings in the assessment with their clinical significance in the patient affected by an environmental emergency. (C-3)
- 5-10.91 Develop a patient management plan based on the field impression of the patient affected by an environmental emergency. (C-3)

AFFECTIVE OBJECTIVES

None identified for this unit.

PSYCHOMOTOR OBJECTIVES

None identified for this unit.

DECLARATIVE

- I. Environmental emergency
 - A. A medical condition caused or exacerbated by the weather, terrain, atmospheric pressure or other local factors
 - 1. Instances of environmental emergencies
 - 2. Environmental impact on morbidity and mortality
 - (1) Environmental stressors that induce or exacerbate other medical or traumatic conditions
 - 3. Role of special rescue resources
 - a. Mountain
 - b. Cave
 - c. Swift water
 - d. Dive
 - B. Risk factors
 - 1. Age
 - 2. General health
 - 3. Fatigue
 - 4. Predisposing medical conditions
 - 5. Medications
 - a. Prescription
 - b. Over the counter (OTC)
 - C. Environmental factors
 - 1. Climate
 - a. Localized prevailing weather norms
 - b. Breadth of deviation from mean
 - c. Effect of deviation from mean
 - 2. Season
 - a. Annual variation of climate
 - b. Localized characteristics of seasonal variation to climate
 - 3. Weather
 - a. Wind
 - b. Rain
 - c. Snow
 - d. Humidity
 - e. Temperature
 - f. Radiation
 - g. Heat
 - h. Cold
 - 4. Atmospheric pressure
 - a. At altitude
 - b. Underwater
 - 5. Terrain
 - a. Injury
 - b. Complications to rescue
 - D. Types of environmental illnesses

1. Heat illnesses
 2. Cold illnesses
 3. Pressurization illnesses
 - a. Over-pressurization illnesses
 - b. Under-pressurization illnesses
 4. Localized injuries
 - a. Frostbite
 - b. Radiation burns, e.g., sunburn
- II. General pathophysiology, assessment and management
- A. Homeostasis
1. "Normal" body temperatures
 - a. Core
 - b. Periphery
 2. Evaluation of body temperatures
 - a. Oral
 - b. Axillary
 - c. Tympanic
 - d. Rectal
 - e. Tactile
- B. Thermoregulation
1. Regulatory center
 2. Peripheral thermoreceptors
 3. Central thermoreceptors
 4. Metabolic rate
 - a. Basal
 - b. Exertional
 - c. Caloric requirements
 5. Heat balancing
 - a. Core versus periphery
 - b. Deep versus superficial veins
 - (1) Counter-current heat exchange
 - (2) Effects of vascular constriction and dilation
 - c. Effect of common drugs on thermoregulation
 - (1) Alcohol
 - (2) Nicotine
 - (3) Aspirin and acetaminophen
- C. Thermogenesis
1. Muscular
 - a. Baseline muscular activity
 - b. Exertion
 - c. Shivering
 2. Metabolic
 - a. Processing of food and nutrients
 - (1) Carbohydrates - sugars and starches
 - (2) Fats
 - (3) Proteins

- b. Glycogen
 - 3. Endocrine
 - a. Role of hormones in setting basal metabolic rate
 - D. Thermolysis
 - 1. Conduction
 - 2. Convection
 - 3. Radiation
 - 4. Evaporation
 - 5. Respiration
- III. Specific pathology, assessment, and management - heat disorders
 - A. Heat illness
 - 1. Definition
 - a. Increased core body temperature (CBT) due to inadequate thermolysis
 - 2. General signs and symptoms
 - a. Signs of thermolysis
 - (1) Diaphoresis
 - (2) Posture
 - (3) Increased skin temperature
 - (4) Flushing
 - b. Signs of thermolytic inadequacy
 - (1) Altered mentation
 - (2) Altered level of consciousness
 - B. Physiology of heat gain and loss
 - 1. Heat gain
 - a. Metabolic heat production
 - (1) Thermogenesis through increased metabolic activity
 - b. Environmental heat gain
 - (1) Heat transfer from the environment
 - 2. Heat loss
 - a. Metabolic heat loss
 - (1) Increased thermolysis from vasodilation
 - b. Environmental heat loss
 - (1) Increased thermolysis from heat transfer to the environment
 - C. Predisposing factors
 - 1. Age
 - a. Pediatric age groups
 - b. Geriatric age groups
 - 2. General health and medications
 - a. Diabetes
 - (1) Autonomic neuropathy interferes with vasodilation and perspiration
 - (2) Autonomic neuropathy may interfere with thermoregulatory input
 - b. Antihypertensive medications
 - (1) Diuretics
 - (a) Predispose to dehydration
 - (2) Beta blockers
 - (a) Interfere with vasodilation

- (b) Reduce capacity to increase heart rate in response to volume loss
 - (c) May interfere with thermoregulatory input
 - c. Psychotropic medications and antihistamines
 - (1) All interfere with central thermoregulation
 - (2) Antipsychotics
 - (3) Antihistamines
 - (4) Phenothiazines
 - d. Acclimatization
 - 3. Length of exposure
 - 4. Intensity of exposure
 - 5. Environmental
 - a. Humidity
 - b. Wind
- D. Preventative measures
 - 1. Maintain adequate fluid intake
 - a. Thirst is an inadequate indicator of dehydration
 - 2. Acclimatize
 - a. Acclimatization results in more perspiration with lower salt concentration
 - b. Increases fluid volume in body
 - 3. Limit exposure
- E. Heat disorders
 - 1. Heat cramps
 - a. Muscle cramps due to dehydration and overexertion
 - b. Not specifically related to heat illness
 - 2. Heat exhaustion (mild heat illness)
 - a. Ill-defined term referring to milder forms of heat illness
 - b. Increased CBT with some neurologic deficit
 - c. Signs of active thermolysis usually present
 - d. Symptoms may be due solely to simple dehydration, combined with overexertion
 - (1) Result is orthostatic hypotension
 - (2) Symptoms resolve with rest and supine positioning
 - (a) Fluids and elevation of knees beneficial
 - e. Symptoms that do not resolve with rest and supine positioning may be due to increased CBT, are predictive of impending heatstroke and must be treated aggressively
 - 3. Heatstroke
 - a. Increased CBT with significant neurologic deficit
 - b. Organ damage
 - (1) Brain
 - (2) Liver
 - (3) Kidneys
 - c. Signs of active thermolysis may be present or absent
 - (1) Classic
 - (a) Commonly presents in those with chronic illnesses
 - (b) Increased CBT due to deficient thermoregulatory function
 - (c) Predisposing conditions include age, diabetes and other medical

- conditions
 - (d) "Hot, red, dry" common
 - (2) Exertional
 - (a) Commonly presents in those who are in good general health
 - (c) Excessive ambient temperature
 - (d) Excessive exertion
 - (e) Prolonged exposure
 - (f) Poor acclimatization
 - (g) "Moist, pale" common
 - F. Role of dehydration in heat disorders
 - 1. Common concomitant syndrome
 - 2. Inhibits vasodilatation and therefore thermolysis
 - 3. Leads to orthostatic hypotension and subsequent symptoms
 - a. Nausea, vomiting, abdominal distress
 - b. Vision disturbances
 - c. Decreased urine output
 - d. Poor skin turgor
 - e. Signs of hypovolemic shock
 - f. May occur with signs or symptoms of heatstroke
 - G. Fever
 - 1. Pathophysiology
 - 2. Differentiation from heatstroke
 - a. History of infection or illness
 - b. Neurological symptoms may present with either
 - c. If unsure, treat for heatstroke
 - H. Treatment
 - 1. Remove from environment
 - 2. Active cooling
 - a. Misting and fanning
 - b. Moist wraps
 - c. Risks of over-cooling
 - (1) Reflex hypothermia
 - d. Use of tepid water for cooling
 - (1) Ice packs and cold water immersion may produce reflex vasoconstriction and shivering due to effect on peripheral thermoreceptors
 - I. Fluid therapy
 - 1. Oral
 - a. Some salt additive is beneficial
 - b. Limited need for other electrolytes in oral rehydration
 - c. Salt tablets
 - (1) May cause GI irritation and ulceration
 - (2) May cause hyponatremia
 - (3) Should be avoided
 - 2. Intravenous
 - a. Normal saline solution preferred
- IV. Specific pathology, assessment, and management - cold disorders

- A. Hypothermia
 - 1. Definition
 - a. Decreased CBT due to
 - (1) Inadequate thermogenesis
 - (2) Excess cold stress
 - (3) A combination of both
- B. Mechanisms of heat loss
 - 1. Physiological
 - 2. Environmental
- C. Predisposing factors
 - 1. Age
 - a. Pediatric age group
 - b. Geriatric age group
 - 2. General health and medications
 - a. Hypothyroidism
 - b. Malnutrition
 - c. Hypoglycemia
 - d. Medications that interfere with thermogenesis
 - (1) Narcotics, phenothiazine, alcohol, and barbiturates
 - (2) Antiseizure medications
 - (3) Antihistamines and other allergy medications
 - (4) Antipsychotics, sedatives, and antidepressants
 - (5) Various pain medications, including aspirin, acetaminophen, and NSAIDs
 - 3. Fatigue and exhaustion
 - 4. Length of exposure
 - 5. Intensity of exposure
 - 6. Environmental
 - a. Humidity
 - b. Wind
 - c. Temperature
- D. Preventative measures
 - 1. Dress
 - 2. Rest
 - 3. Food
 - 4. Limit exposure
- E. Categories of hypothermia
 - 1. Severity
 - a. Mild
 - (1) Presence of signs and symptoms with a CBT that is greater than 90° F
 - b. Severe
 - (1) Presence of signs and symptoms with a CBT that is less than 90° F
 - c. Compensated
 - (1) Presence of signs and symptoms with a normal CBT
 - (2) CBT being maintained by thermogenesis
 - (3) As energy stores (liver and muscle glycogen) are exhausted, CBT will drop
 - 2. Onset

- a. Acute (immersion)
 - b. Subacute (exposure)
 - c. Chronic (urban)
 - 3. Primary vs. secondary hypothermia
 - a. Cold exposure may be primary cause of hypothermia
 - b. Hypothermia may be secondary to other problems
- F. Principal signs and symptoms
 - 1. No reliable correlation between signs or symptoms and specific CBT
 - 2. Signs of thermogenesis efforts
 - 3. Diminished coordination and psychomotor function
 - 4. Altered mentation
 - 5. Altered level of consciousness
 - 6. Cardiac irritability
 - a. Presence of "J" wave on ECG; not useful, diagnostically
- G. Specific treatment
 - 1. Stop heat loss
 - a. Remove from environment
 - b. Dry
 - c. Wind/ vapor/ moisture barrier
 - d. Insulate
 - 2. Rewarming
 - a. Passive external
 - (1) Insulation
 - (2) Wind/ vapor/ moisture barrier
 - b. Active external
 - (1) Heat packs
 - (a) Placed over areas of high heat transfer with core
 - i) Base of neck
 - ii) Axilla
 - iii) Groin
 - (b) Insulate underneath to prevent burning
 - (2) Heat guns
 - (3) Lights
 - (4) Warm water immersion
 - (a) 102° F to 104° F
 - (b) Can induce rewarming shock
 - (c) Little application in out-of-hospital setting
 - c. Active internal
 - (1) Warmed (102° F to 104° F) humidified oxygen
 - (2) Warmed (102° F to 104° F) intravenous administration
 - (3) Role of warmed administration
 - (a) Crucial, to prevent further heat loss
 - (4) Limitations of warmed administration
 - (a) Actual heat transferred is minimal
 - (b) limited contribution to rewarming
 - 3. Rewarming shock
 - a. Active external rewarming causes reflex vasodilation

- b. Requires more heat transference than is possible with methods available in out-of-hospital setting
 - c. Easily prevented by IV fluid administration during rewarming
 - 4. Cold diuresis and the need for fluid resuscitation
 - a. Oral
 - b. Intravenous
 - 5. Resuscitation considerations
 - a. BCLS considerations
 - (1) Increased time to evaluate vital signs
 - (2) Use of normal chest compression and ventilation rates
 - (3) Use of oxygen
 - (4) AED recommendations
 - b. ACLS considerations
 - (1) Effects of cold on cardiac medications
 - (2) Considerations for airway management
 - (a) No increased risk of inducing ventricular fibrillation (V-fib) from orotracheal or nasotracheal intubation
 - (3) AHA recommendations
 - (4) Risks and management of V-fib
 - (a) Risks of V-fib related both to depth and duration of hypothermia
 - (b) Rough handling can induce V-fib
 - (c) It is generally impossible to electrically defibrillate a hypothermic heart that is colder than 86° F
 - (d) Lidocaine and procainamide paradoxically lower fibrillatory threshold in a hypothermic heart and increase resistance to defibrillation
 - (e) Bretylium and magnesium sulfate may be effective even in hypothermic hearts
 - 6. Transport considerations
 - a. Gentle transportation necessary due to myocardial irritability
 - b. Transport with patient level or head slightly head down
 - c. General rewarming options of destination
 - d. Availability of cardiac bypass rewarming preferable in destination consideration
 - H. Local cold injuries
 - 1. Frostbite
 - a. Classifications
 - (1) Superficial
 - (a) Also referred to as frostnip
 - (b) Some freezing of epidermal tissue
 - (c) Initial redness followed by blanching
 - (d) Diminished sensation
 - (2) Deep
 - (a) Freezing of epidermal and subcutaneous layers
 - (b) White appearance
 - (c) Hard (frozen) to palpation
 - (d) Loss of sensation
 - b. Treatment

- (1) Transport to hospital for rewarming by immersion
 - (2) Rewarm rapidly, by immersion, if transport will be delayed
 - (a) 104° F max
 - (b) Do not rewarm if there is risk of re-freezing
 - (c) Consider analgesics
 - (3) Transport considerations
 - (a) Immobilize
 - (b) Do not rewarm extremities if needed for transport (walking)
 - 2. Trench foot (immersion foot)
 - a. Similar to frostbite but occurs at temperatures above freezing
 - (1) Associated with prolonged exposure to moisture
 - b. Principal signs and symptoms
 - (1) Similar to frostbite
 - (2) Blisters may form upon spontaneous rewarming
 - (3) Pain
 - c. Specific treatment
 - (1) Dry and warm
 - (2) Aerate

- V. Specific pathology, assessment, and management - near-drowning
 - A. Definition
 - 1. Submersion episode with at least transient recovery
 - B. Pathophysiology
 - 1. Wet versus dry drownings
 - a. Fluid in posterior oropharynx stimulates laryngospasm
 - b. Aspiration occurs after muscular relaxation
 - c. Suffocation occurs with or without aspiration
 - d. Aspiration presents as airway obstruction
 - 2. Fresh versus saltwater considerations
 - a. Despite mechanistic differences, there is no difference in metabolic result
 - b. No difference in out-of-hospital treatment
 - 3. Hypothermic considerations in near-drownings
 - a. Common concomitant syndrome
 - b. May be organ protective in cold-water near-drownings
 - c. Always treat hypoxia first
 - d. Treat all near-drowning patients for hypothermia
 - C. Treatment
 - 1. Establish airway
 - a. Conflicting recommendations regarding prophylactic abdominal thrusts
 - b. Questionable scientific data to support prophylactic abdominal thrusts
 - 2. Ventilation
 - 3. Oxygen
 - D. Trauma considerations
 - 1. Immersion episode of unknown etiology warrants trauma management
 - E. Post-resuscitation complications
 - 1. Adult respiratory distress syndrome (ARDS) or renal failure often occur post-resuscitation
 - 2. Symptoms may not appear for 24 hours or more, post-resuscitation

3. All near-drowning patients should be transported for evaluation
- VI. Specific pathology, assessment, and management - diving emergencies
- A. Application of gas laws
 1. Boyle's law
 2. Dalton's law
 3. Henry's law
 - B. Pathophysiology
 1. Increased pressure dissolves gasses into blood
 - a. Oxygen metabolizes
 - b. Nitrogen dissolves
 2. Primary etiology is too rapid an ascent from depth
 - C. Classification of diving emergencies
 1. Decompression illnesses
 - a. Excess nitrogen bubbles out of solution on depressurization
 - b. Occurs in joints, tendons, spinal cord, skin, brain, inner ear
 - c. Occludes circulation
 - d. Principal signs and symptoms
 - (1) Joint pain
 - (2) Fatigue
 - (3) Paresthesias
 - (4) CNS disturbances
 - e. Specific treatment
 - (1) High flow oxygen
 - (2) Treat for shock
 - (3) IV initiation
 - (4) Place patient in supine position
 - (5) Transport to emergency department
 - (6) Definitive care is typically hyperbaric oxygen therapy (HBO)
 2. Pulmonary over-pressure accidents
 - a. Air trapped in lungs by
 - (1) Breath holding
 - (2) Bronchospasm
 - (3) Mucous plug
 - b. Shallow depths (<6') most dangerous
 - c. Pressure decreases and volume increases on ascent
 - d. Lung tissue ruptures in severe cases, producing a pneumothorax
 - e. Principal signs and symptoms
 - (1) Respiratory distress
 - (2) Substernal chest pain
 - (3) Diminished breath sounds
 - f. Specific treatment
 - (1) Rest
 - (2) Supplemental oxygen
 - (3) Hyperbaric oxygen not usually required
 - (4) Treatment is the same as for pneumothorax of any etiology
 3. Arterial Gas Embolism (AGE)

- a. Air in bloodstream secondary to pulmonary over-pressure
 - (1) Access to pulmonary circulation from ruptured alveoli
 - (2) Entrance to central circulation via left atrium
- b. Occlusion of small vessels occurs
 - (1) Cardiac compromise
 - (2) Pulmonary compromise
 - (3) Cerebral compromise
- c. Principal signs and symptoms
 - (1) Usually appear within 10 minutes of surfacing (most commonly within 2 minutes)
 - (2) Varies according to organ system that is primarily affected
 - (3) Most common presentation is similar to cerebral vascular accident
 - (a) Hemispheric presentations are rare
 - (b) Vertigo
 - (c) Confusion
 - (d) Loss of consciousness
 - (e) Visual disturbances
- d. Specific treatment
 - (1) High flow oxygen
 - (2) Transport supine, not in Trendelenburg
 - (3) Best treatment may be immediate hyperbaric oxygen
 - (4) Treat as for near-drowning
 - (5) Treat according to other symptoms
 - (6) Attempt to keep the patient at or below the altitude of the injury during transport
- 4. Nitrogen narcosis
 - a. Excess nitrogen dissolved in bloodstream under pressure
 - (1) Most common appearance is at depths of 70-100 feet
 - b. Gas anesthetic effect due to lipid solubility
 - c. Result is intoxication
 - (1) Accidents at depth often result from impaired judgement
 - d. Principal signs and symptoms
 - (1) Intoxication, impaired judgement
 - (2) Altered level of consciousness
 - e. Specific treatment
 - (1) Self-resolving upon ascent
 - (2) Return to shallow depths
- 5. Other diving related illnesses
 - a. Oxygen toxicity
 - (1) Usually seen only with prolonged exposure or excess concentration
 - b. Contaminated gases
 - c. Hypercapnia
 - d. Hyperventilation
- D. Divers Alert Network (DAN)
 - 1. Non-profit organization affiliated with Duke University Medical Center
 - 2. Specializes in diving related illnesses
 - 3. Available for consultation and referral

4. (919) 684-8111 for emergencies
 5. (919) 684-2948 for non-emergency consultation and referral
- VII. Specific pathology, assessment, and management - altitude illness
- A. Application of gas laws
 - B. Exposure to high altitude may exacerbate chronic medical conditions, even without inducing altitude illness
 1. Angina pectoris
 2. Congestive heart failure
 3. Chronic obstructive pulmonary disease
 4. Hypertension
 - C. Etiology and epidemiology of altitude illnesses
 1. Principal occurrence over 8000 feet above sea level
 2. Hypoxic basis
 3. Incidence
 - D. Predisposing factors
 1. None
 2. Typically presents in otherwise healthy individuals
 3. Only predictor is hypoxic ventilatory response
 - E. Preventative measures
 1. Gradual ascent
 2. Limited exertion
 3. Decreased sleeping altitude
 4. High carbohydrate diet
 5. Acetazolamide
 - a. Speeds acclimatization and decreases incidence of acute mountain sickness
 6. Nifedipine
 - a. Used solely by those with a previous history of high altitude pulmonary edema to prevent re-occurrence upon ascent
 7. Steroids - efficacy is controversial
 - F. Signs and symptoms
 1. Malaise
 2. Anorexia
 3. Headache
 4. Sleep disturbances
 5. Respiratory distress that increases with exertion
 - G. Categorization of altitude illnesses
 1. Acute mountain sickness (AMS)
 - a. Mild
 - b. Severe
 2. High altitude pulmonary edema (HAPE)
 - a. Pulmonary edema develops from increased pulmonary artery pressure
 3. High altitude cerebral edema (HACE)
 - a. Cerebral edema develops from unknown causes and produces increased intracranial pressure
 - H. Treatment
 1. Descent

2. Oxygen
3. Portable hyperbaric chamber
4. Medications
 - a. Acetazolamide for AMS, HAPE, or HACE
 - b. Nifedipine for HAPE only
 - c. Steroids for severe AMS or HACE only
 - d. Adjunctive medications
 - (1) Prochlorperazine for AMS or HACE
 - (2) Furosemide for HAPE
 - (3) Morphine for HAPE

VIII. Integration

- A. Impact of the environment on human metabolism
 1. Heat gain or loss that exceeds the body's capacity to compensate
 2. Pressure changes that exceed the body's capacity to compensate
- B. Assessment findings in patients with environmentally induced illnesses
 1. Abnormal core body temperatures
 2. Signs of metabolic decompensation
 3. Development of shock state
- C. Patient management
 1. Field stabilization
 - a. Removal of environmental influence
 - b. Support of metabolic compensation
 - c. Selection of definitive care location